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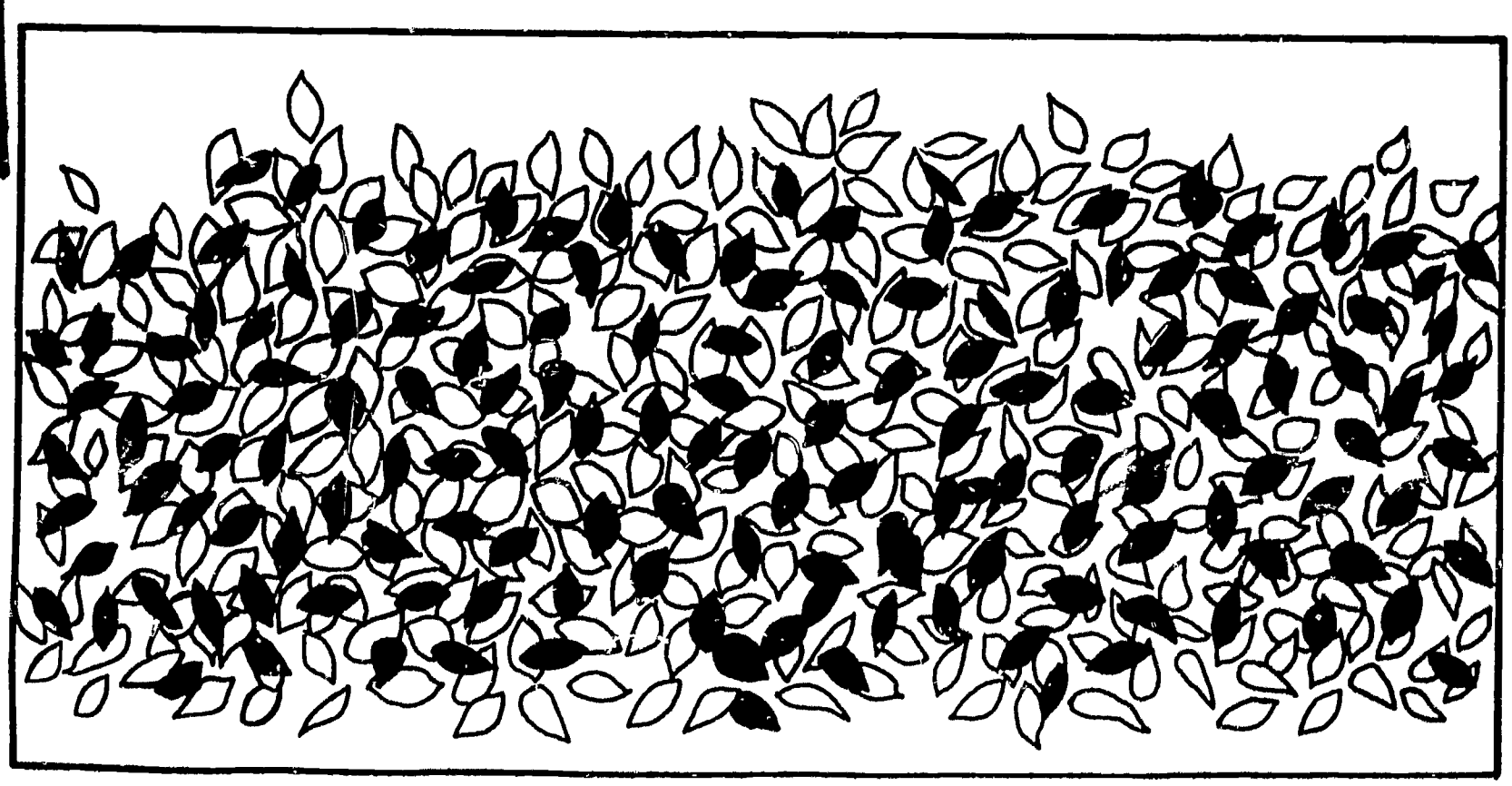
This booklet gives the rationale and objectives of the Science: Grades K-6 course developed by the North Carolina Public Schools. It is designed to give an outline for introducing the program to principals and teachers. A set of transparencies is available for use with it. The program suggested closely follows the conceptual schemes developed by the National Science Teachers Association and outlines methods for each school to develop its own sequence of topics. (GR)

A GUIDE TO SCIENCE GRADES K-6



NORTH CAROLINA PUBLIC SCHOOLS

A GUIDE TO SCIENCE: GRADES K-6

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A GUIDE TO SCIENCE: GRADES K-6

This booklet is designed to introduce SCIENCE: GRADES K-6. It gives an overview of what SCIENCE: GRADES K-6 is all about, how and why it was developed, what it contains, and how it can be used to stimulate interest in and study of the local science curriculum.

The booklet offers suggestions for planning programs to introduce the bulletin to principals and teachers. A set of materials that can be used for the production of transparencies are available for use with such programs.

WHY SCIENCE: GRADES K-6 WAS DEVELOPED

The recent interest in elementary science education around the nation is also manifested in North Carolina Schools. With this interest and the development of related curricular materials has come a growing concern by teachers for help in developing an adequate instructional program that they can use to provide for the individual needs of students. Schools and administrative units throughout the State have been requesting guidance in developing and adopting science programs that reflect the latest in educational thought. In response to these requests, the science staff of the Department of Public Instruction is introducing SCIENCE: GRADES K-6.

HOW IT WAS DEVELOPED

During the summer of 1966, an Elementary Science Bulletin Advisory Committee was organized representing teachers, principals, supervisors and science educators. This group was given the task of determining what the nature of such a bulletin should be in order to meet the needs of North Carolina schools.

In order to answer this question, careful attention was given to the nature of the schools to be served and the needs of students and teachers involved. Teaching guides of other states were examined and advice of specialists from schools, colleges and universities was solicited.

As a result of this study, in September of 1966 a number of suggested formats were sent to interested and knowledgeable persons throughout the State for their reactions. From their responses, the advisory committee, meeting in November of that year, drew together the ideas which had been submitted and made further recommendations.

Following this meeting, ideas, suggestions and recommendations were synthesized and a format for the bulletin was developed.

Based on the approved approach and format, writing of the bulletin was begun during the winter of 1966-67. To insure the appropriateness and readability of the contents, several hundred elementary school teachers from throughout the State were involved in reviewing and editing the materials. Much of the actual writing was done by Dr. Paul W. Welliver, then Consultant in Science Education with the Department of Public Instruction.

HOW THE BULLETIN IS ORGANIZED

Introduction

The first part of SCIENCE: GRADES K-6 states the rationale behind the development of the bulletin and suggests ways in which it may be used. Various procedures which a school may employ are discussed. These procedures vary, depending upon whether the school desires a set program to follow, a guide for developing its own program, or assistance in improving an already established program. The nature of these variations is reflected in discussions of the other sections of the bulletin.

Objectives of Elementary School Science

In this section, three lists of objectives for an elementary science program are cited and the importance of such educational objectives is discussed. The lists of objectives reflect varied approaches and points of view.

Teachers are encouraged to discuss these objectives and come to agreement about the objectives they wish to implement in their program. These might come from one of the lists provided, but hopefully it will be a list that they have developed for themselves. Provision is made so that objectives decided upon can be inserted in the back and made a permanent part of the bulletin.

Scope of Science Topics

Essential to an effective elementary science program is the development of a scope of topics which comprises the subject matter content of science instruction from kindergarten through grade six. Here again, three approaches to development of scope are discussed. This section also features a detailed and

comprehensive outline of topics which a group of teachers can adopt, add to, delete from, or revise to develop a scope of topics to be included in the instructional program. The scope of science topics decided upon can also be inserted in the back of the bulletin and made readily available for use.

Sequence of Topics

In order to avoid frequent and unnecessary repetition of subject matter in subsequent grades, it is essential that a sequence of topics to be taught be developed within a school. Samples of possible sequences are presented and discussed in this section. Again, teachers should develop a sequence which reflects the order, grade level and relationship of science topics they wish to adopt. This sequence could be one of those which is suggested, a sequence provided by the state-adopted text series, an already established sequence being used in the school or one which the teachers develop themselves.

The sequence of topics developed should be inserted in the back of the bulletin along with the previously completed lists of objectives and scope of science topics.

Unit Preparation

In this section, a discussion of the value of the unit method of teaching is included along with suggestions for unit design. An illustrative unit, prepared by a North Carolina teacher, is included to show how materials, methods and resources can be blended to implement the objectives established for the science program. Again, teachers are urged to develop their own plans for preparation of units and to devise a long range plan for evaluation and revision of units used.

Activities

As an aid to planning by the classroom teacher, approximately 700 activities covering various areas of science are described. Basic concepts, required materials, procedures to follow and needed background information are presented in the sections "Introduction to Science," "Living Things," "Matter and Energy," and "Earth and Space." All of the activities contained in the bulletin were field-tested by practicing elementary school teachers.

Teachers are urged to determine the grade level suitability of activities and their appropriateness for helping children gain understanding of related concepts. Color-blocks for all activities listed are provided in which these notations can be made.

Evaluation

Following the activities section of the bulletin is a discussion of the purposes and methods for evaluating student growth in understanding, performance and development of desired attitudes with suggestions for developing a definite plan for continual evaluation by the teacher. Each teacher can develop her own plans for evaluation and insert them in the back of the bulletin.

Appendices

The remainder of the bulletin consists of appendices covering areas about which elementary school teachers most often want information and help.

Appendix A includes information about:

- Preparing for and conducting field trips with suggestions of places to visit.
- How to care for living things in the classroom with suggestions about where to collect them, what they eat, and common causes for failure.
- How to prepare and maintain fresh-water aquaria, woodland, semi-aquatic and desert terraria.

- How to collect, prepare and display insects.
- How to work with glass tubing.
- How to make electrical circuits and the proper use of batteries, bulbs and meters.
- How to make accurate measurements.
- Sources of additional information on procedures and techniques.

Appendix B covers aspects of safety in relation to such things as:

- General safety practices.
- Handling of plants, live animals and bacteriological cultures.
- Storage and use of harmful chemicals.
- Design, construction and handling of electrical circuits and appliances.
- Handling and use of glassware in the classroom.

Appendix C consists of a list of equipment and materials required to perform experiments and activities listed in the bulletin with space provided for making a school inventory. Also included is a general listing of materials for establishing what is needed to provide a basic, standard and advanced science program with space provided for determining the present status of equipment in the school.

Appendix D consists of a series of illustrations of commonly used items of science equipment to help the teacher become familiar with those usually found in schools and often referred to in science texts.

Appendix E includes a checklist which can be used by teachers and administrators in evaluating the effectiveness of practices and procedures used to implement the philosophy and objectives of the science program, on a school-wide or grade level basis.

Appendix F is a bibliography of professional references covering various aspects of an elementary science program.

HOW YOU CAN USE THE BULLETIN

The purpose of SCIENCE: GRADES K-6 is to provide opportunity for teachers and schools to develop a modern and coordinated program in elementary science which is suited to the needs and resources of the local community. In a study such as this, it is best to have teachers work together in groups under the skilled leadership of someone who can insure compatibility of group goals and continuity of efforts of those involved. If it is decided to make the study a cooperative effort, the following steps are suggested.

1. Decide on the size of the group which will be working on the science study project. It is suggested that the minimum size be the entire faculty of a single school although the faculties of several schools or of an entire administrative unit may wish to work together. If the latter method is used, keep in mind that the effectiveness of the study will depend to a large measure on how much opportunity each individual teacher has to become personally involved. Too large a group might inhibit desired interaction and some teachers will not be able to become functioning members of the group.

2. Early meetings should be devoted to discussions of general topics such as the need for study of the science program, recent trends in elementary science education, the status of the present program and other topics of interest to participants. During these meetings, every effort should be made to insure that each teacher has opportunity to make personal contributions to discussions and become part of the group. The group leader should be aware of those aspects of group dynamics which make for good interaction and be prepared to let the group assume gradual control.

   During these discussions, the group should come to an agreement about the objectives for such a study, define basic problems and establish priorities for aspects of the study. All resources and materials that might be of help should be assembled and made available to the group. A list of professional references is included in the Bulletin and can be

used as a resource guide. The group may wish to invite consultants to provide background information on such things as trends in science education, learning theory, new materials and approaches, goals and objectives for elementary science education and other topics pertinent to the study. The Department of Public Instruction and local colleges and universities are sources for consultant services.

3. Once this background has been established, subsequent sessions should be devoted to developing specific objectives for the science program, selecting concepts to be developed, and formulating the scope and sequence of material to be included in the total program and at individual grade levels.

At this point, teachers may wish to work in sub-groups to focus attention on portions of a topic. For example, teachers may want to meet separately to consider the typical needs and abilities of children at a single grade level before developing the scope and sequence of topics for the entire K-6 program.

In discussing scope and sequence of specific topics, it is likely that teachers will evidence disagreement. This is not an unusual reaction and is an indication of the degree to which individual teachers understand objectives which have been established. If this occurs, review and further discussion will be needed to determine if objectives are realistic and meaningful to members of the group. If they are not, it will be necessary to continue discussions and restate the objectives in terms that all teachers understand.

The format of the bulletin is such that it can serve as a guide to these discussions, provide step-by-step procedures that can be followed by discussion groups, and make it possible for each teacher to have his own personal copy of objectives and scope and sequence developed.

4. When objectives and scope and sequence have been established for the total program and for topics within a single grade, the activities section of the bulletin can be examined to determine the suitability of specific activities for helping develop concepts in each grade. Here again, it

is likely that teachers will want to work in small groups, and the principal or supervisor should insure that groups come together often enough so the entire group can benefit from the thinking of all. Once activities are evaluated and categorized, they can be used in developing particular units of study.

5. Following this phase of the study, teachers should be encouraged to develop units of study for topics to be considered in a particular grade. It may be necessary at this point for teachers to meet again in larger groups to make use of consultants and other resources to consider how teaching units should be organized to involve students in an activity-centered inquiry approach. Discussions about science and inquiry and the role of the teacher in this type of program will likely be needed as modern trends in elementary science education stress this approach.

   Again, the bulletin provides a background for discussion and suggests references that might be used in developing this aspect of the study.

When a study such as the one described is completed, the bulletin will serve as a basis for science instruction for each teacher. Inserted in the back of each bulletin will be a complete program for grades K-6 with specific information relative to the grade with which the teacher is working.

Program development is a continuous process. Materials which are developed and made part of the bulletin should be constantly reviewed and revised. Wide margins are provided in the bulletin for notes by the teacher regarding practices useful in using materials and for up-dating the program.

Each teacher should be encouraged to evaluate her effectiveness and alter her approach so that maximum effectiveness is obtained. The bulletin contains suggestions relating to self-evaluation and can be used for furthering group discussions about this aspect of instruction.

OUTLINES OF SUGGESTED PROGRAMS

This section contains outlines of programs that might be used by a supervisor or principal who is working with a group of teachers involved in a study of the science curriculum.

Outlines were kept simple and can best be used to introduce a topic for general group discussion. As such, the outlines suggest ways in which the discussion "leader" can direct the thinking of the group toward the various topics considered.

If the programs are to be used, it is suggested that review of materials in the bulletin be done prior to the meetings and that teachers bring their copies with them to the meetings. Transparency masters are available so that transparencies may be produced for use with each program.

Summaries of the programs are offered here for consideration.

PROGRAM A - AN INTRODUCTION TO SCIENCE: GRADES K-6

An outline of the program presented at the area meetings with suggestions as to how the bulletin might be introduced to supervisors and principals who did not attend. Primary emphasis of the program is to stimulate interest in developing a local study of the science program. Thirteen transparency masters are available for this program. (This program can also be used by a principal or supervisor to introduce the bulletin to teachers).

PROGRAM B - OBJECTIVES FOR AN ELEMENTARY SCIENCE PROGRAM

An outline of a program that can be used to stimulate discussion of objectives for an elementary science program. Aspects of what objectives should do and what they should include are considered with suggestions about what the group might discuss. SCIENCE: GRADES K-6 is considered a resource for developing science objectives. Six transparency masters are available for this program.

PROGRAM C - SCOPE AND SEQUENCE FOR AN ELEMENTARY SCIENCE PROGRAM

This program discusses aspects of scope and sequence as they apply to the development of a local science program. Suggestions are given regarding how scope and sequence can be developed and how SCIENCE: GRADES K-6 can be utilized as a resource for these discussions. Five transparency masters are available for this program.

PROGRAM D - TEACHING UNITS

This program considers how teaching units can be used to develop the objectives, scope and sequence of an elementary science program. Suggestions are given about unit development and how SCIENCE: GRADES K-6 can be used by the teacher in developing units of his own. Five transparency masters are available for this program.

PROGRAM E - EVALUATION

This program discusses aspects of evaluation as it applies to assessment of both the total program and of teacher effectiveness in implementing objectives. Suggestions are given to direct the discussion toward consideration of present evaluative efforts and how teachers can develop more comprehensive techniques. Four transparency masters are available for use with this program.

PROGRAM A - AN INTRODUCTION TO SCIENCE: GRADES K-6

(Use transparency A)

This is a outline of the program presented at the area meetings with suggestions as to how the bulletin might be introduced to supervisors and principals who did not attend. Primary emphasis of the program is to stimulate interest in developing a local study of the science program. Thirteen transparency masters are available for this program. (The program can also be used by a principal or supervisor to introduce the bulletin to teachers).

1. WHY SCIENCE: GRADES K-6 WAS DEVELOPED (Use transparency A-1)

   Discuss recent developments in elementary science education. Refer to section entitled "New Elementary Science Programs" in booklet A Guide to Science: Grades K-6 for sources of information relating to some of the new programs and materials being developed. Have principals or teachers discuss some of their concerns relative to these developments.

2. HOW SCIENCE: GRADES K-6 WAS DEVELOPED (Use transparency A-2)

   Have participants discuss the needs of teachers and students in their school. Ask for comments about teachers and others in the school unit who might have contributed to the work of the Elementary Science Bulletin Advisory Committee.

3. HOW THE BULLETIN IS ORGANIZED (Use transparency A-3)

   This is a general overview of how the bulletin is arranged. Have participants examine their copies of SCIENCE: GRADES K-6 more closely at this time.

4. OBJECTIVES OF ELEMENTARY SCHOOL SCIENCE (Use transparency A-4)

   Have participants refer to section on Objectives and discuss objectives of their present program. Show how the bulletin is organized to encourage teachers to develop a set of objectives for their own program.

5. SCOPE OF SCIENCE TOPICS (Use transparency A-5)

Have participants consider the topics in their present science program and discuss ways in which a scope can be developed.

6. SEQUENCE OF SCIENCE TOPICS (Use transparency A-6)

Discuss the need for orderly arrangement of science topics to insure coordination and continuity of a science program. Consider how the bulletin can be used to help them develop a sequence of science topics for their program.

7. HOW TO DEVELOP TEACHING UNITS (Use transparency A-7)

Discuss the value of the unit method of teaching and have the group consider the arrangement of the illustrative unit in the bulletin. Describe how the bulletin can aid teachers in developing units of their own.

8. ACTIVITIES (Use transparency A-8)

Have the group look over the activities included in the bulletin, note their arrangement, and point out how teachers can evaluate and categorize them for use in unit planning.

9. EVALUATION OF AN ELEMENTARY SCIENCE PROGRAM (Use transparency A-9)

Discuss the need for evaluation of the degree of implementation of the program and of student growth. Have participants discuss the evaluation checklist and consider their role in the evaluative process.

10. APPENDICES (Use transparency A-10, A-11, A-12)

Have participants look over the appendices and point out how each might be helpful to their science program.

11. SUMMARY

Have the group discuss ways in which they can initiate study of the science program in their school. Point out that other programs are available to help stimulate interest and give direction to such a study. (Have principals consider aspects of supervision that relate to working with groups in such a study and ways to make the study successful).

PROGRAM B - OBJECTIVES FOR AN ELEMENTARY SCIENCE PROGRAM
(Use transparency B)

An outline of a program that can be used to stimulate discussion of objectives for an elementary science program. What objectives should do and what they should include are considered with suggestions about what the group might discuss. SCIENCE: GRADES K-6 is considered as a resource for developing science objectives. Six transparency masters are available for this program.

1. WHY HAVE OBJECTIVES? (Use transparency B-1)

   Have the group discuss the objectives of the present program if stated. If not, have them try to determine what their objectives seem to be based on what they are now doing in the classroom.

2. WHAT SHOULD OBJECTIVES PROVIDE? (Use transparency B-2)

   Have the group discuss the kinds of behavioral changes desired and how objectives can provide for selection and organization of content, procedures and activities.

3. WHAT SHOULD OBJECTIVES CONSIDER? (Use transparency B-3)

   Have the group discuss and try to come to agreement about the nature of science, how children learn, the nature of the teacher, the role of science in the total instructional program and the nature of society and the community. (It is not likely that teachers will be able to consider all aspects of these questions but it will be helpful for them to have these questions in mind.)

4. HOW CAN OBJECTIVES BE EXPRESSED? (Use transparency B-4)

   Have the group discuss the statements found in the bulletin that quote from:

   - Policies for Science Education
   - Theory Into Action In Science Curriculum Development
   - Science For The Elementary School

5. HOW SHOULD WE GO ABOUT DEVELOPING OUR OWN OBJECTIVES?

(Use transparency B-5)

Have the group look over the bibliography included in the bulletin and discuss ways in which they can organize to begin discussion of desired objectives. Show how the bulletin can be used as a guide to developing objectives and how they can be made a part of the bulletin.

6. SUMMARY

Review the highlights of discussion about why objectives are important, what objectives should provide, what they consider and how they can be expressed. Make plans for subsequent sessions to discuss objectives.

PROGRAM C - SCOPE AND SEQUENCE FOR AN ELEMENTARY SCIENCE PROGRAM
(Use transparency C)

This program discusses scope and sequence as they apply to the development of a local science program. Suggestions are given regarding how scope and sequence can be developed and how SCIENCE: GRADES K-6 can be utilized as a resource for these discussions. Five transparency masters are available for this program.

1. WHAT IS SCOPE AND SEQUENCE? (Use transparency C-1)

   Have the group consider the scope and sequence of their current program to point out any present inadequacies.

2. HOW CAN SCOPE BE DEVELOPED? (Use transparency C-2)

   Have the group review the statements quoted in the bulletin from:
   - Science: A Process Approach
   - Theory Into Action In Science Curriculum Development

   Encourage discussion about the value of a conceptual schemes approach.

3. WHAT ARE THE GOALS OF SEQUENCE PLANNING? (Use transparency C-3)

   Have the group consider the need for sequential development of topics both for the total K-6 program and within single grades.

   Encourage discussion about ways in which sequence can be developed for gradual expansion of conceptual schemes.

4. HOW CAN WE ORGANIZE FOR SCOPE AND SEQUENCE PLANNING?
   (Use transparency C-4)

   Have the group discuss ways to approach the problem of establishing realistic scope and sequence. The bulletin can serve as a guide to this and suggests a procedure to follow. Show how scope and sequence "charts" can be kept as part of the bulletin.

5. SUMMARY

   Review the major points of discussion about scope and sequence development and make plans for subsequent sessions devoted to establishing scope and sequence for the science program.

PROGRAM D - TEACHING UNITS
(Use transparency D)

This program considers how teaching units can be used to develop the objectives, scope and sequence of an elementary science program. Suggestions are given about unit development and how SCIENCE: GRADES K-6 can be used by the teacher in developing units of his own. Five transparency masters are available for this program.

1. WHAT CAN TEACHING UNITS DO? (Use transparency D-1)

   Have teachers discuss ways in which they have utilized resources and materials in a teaching unit to accomplish specific objectives.

   Consider how teaching units serve to bring objectives, concepts, topics and activities together with suitable resources.

2. WHAT CAN TEACHING UNITS INCLUDE? (Use transparency D-2)

   Discuss why it is necessary to have objectives in mind when developing a unit. Have the group discuss the things they consider when developing a teaching unit.

3. IN WHAT FORM CAN UNITS BE DEVELOPED? (Use transparency D-3)

   Have teachers refer to the sample unit in the bulletin and show how it makes use of the various aspects of unit development. Encourage them to consider what is meant by teacher objectives, student objectives, motivational activities and learning activities.

4. HOW CAN WE ORGANIZE FOR UNIT PLANNING? (Use transparency D-4)

   Have the group discuss the need for having each teacher develop her own units and the value of having an exchange of ideas between teachers. Encourage discussion of the value of the inquiry approach.

5. SUMMARY

   Review the major points of discussion about teaching units and how they can be developed. Point out how the bulletin can serve as a guide to unit planning and make plans for teachers to meet and discuss their own unit outlines.

PROGRAM E - EVALUATION

(Use transparency E)

This program discusses aspects of evaluation as it applies to assessment of both the total program and of teacher effectiveness in implementing objectives. Suggestions are given to direct the discussion toward consideration of present evaluative efforts and how teachers can develop more comprehensive techniques. Four transparency masters are available for use with this program.

1. WHAT ARE THE PURPOSES OF EVALUATION? (Use transparency E-1)

   Have the group discuss why evaluation is needed for the total program and for assessing student growth.

   Develop the idea that continual evaluation is needed to provide for diagnosis of the program and how this can encourage individualized instruction.

2. WHAT SHOULD EVALUATION DO? (Use transparency E-2)

   Have the group discuss what they assess when evaluating an approach to teaching or when they are evaluating student growth. Develop the idea that techniques for measuring knowledge of content differ from those which measure skill in use of processes.

3. HOW DO WE EVALUATE? (Use transparency E-3)

   Have the group discuss the types of instruments and techniques they use when evaluating students to determine where their major emphasis really is. Have them discuss the problem of measuring attitude development.

4. HOW CAN WE DEVELOP INSTRUMENTS AND TECHNIQUES FOR EVALUATION?

   Have the group discuss the evaluation checklist found in the bulletin. Suggest that they use it in their classrooms (as a possible "homework" assignment for discussion at a subsequent meeting) and encourage them to develop a similar checklist of their own.

5. SUMMARY

   Review the major points explored and make plans for subsequent sessions devoted to evaluation.

ADDITIONAL RESOURCES

The following materials are offered as an aid to the supervisor or principal who is helping teachers with a study of the science program in a school. The materials include statements of:

- The Objectives of Science Education.
- Characteristics of A Good Science Program.
- Major Items in The Processes of Science.
- Major Conceptual Schemes.
- New Elementary Science Programs.
- Evaluating The Elementary Science Program.
- Professional References.

OBJECTIVES OF SCIENCE EDUCATION

- To Know the Fundamental Facts and Principles of Science.
- To Possess the Abilities and Skills Needed to Engage in the Process of Science.
- To Understand the Investigative Nature of Science
- To Have Attitudes About and Appreciations of Scientists, Science, and the Consequences of Science That Stem from Adequate Understanding.

CHARACTERISTICS OF A GOOD SCIENCE PROGRAM

A good science program is characterized by many directly observable activities. All teachers participate in its development and in formulating the overall objectives of instruction.

A good science program

1. Is purposeful.
2. Develops intellectual skills of scientific inquiry.
3. Encourages basic concept formation.
4. Develops laboratory skills.
5. Is based on pupil experiences and activities, both real and contrived.
6. Develops an appreciation of the scientific enterprise through the history, philosophy, and biography of science.
7. Makes the most effective use of available instructional aids and resources.
8. Involves a planned sequence of science instruction on a K-12 basis.
9. Involves all teachers in program planning.
10. Is planned but flexible.
11. Keeps abreast of scientific developments.
12. Attracts competent teachers who are science-oriented.
13. Contributes to other curriculum areas.

MAJOR ITEMS IN THE PROCESSES OF SCIENCE AS DEFINED BY THE NATIONAL SCIENCE TEACHERS ASSOCIATION

1. Science proceeds on the assumption, based on centuries of experience, that the universe is not capricious.

2. Scientific knowledge is based on observation of samples of matter that are accessible to public investigation in contrast with purely private inspection.

3. Science proceeds in a piecemeal manner, even though it also aims at achieving a systematic and comprehensive understanding of various sectors or aspects of nature.

4. Science is not, and probably never will be, a finished enterprise, and there remains very much to be discovered about how things in the universe behave and how they are interrelated.

5. Measurement is an important feature of most branches of modern science because the formulation as well as the establishment of laws is facilitated through the development of quantitative distinctions.

MAJOR CONCEPTUAL SCHEMES DEVELOPED BY NATIONAL SCIENCE TEACHERS ASSOCIATION

1. All matter is composed of units called fundamental particles, under certain conditions these particles can be transformed into energy and vice versa.

2. Matter exists in the form of units which can be classified into hierarchies of organizational levels.

3. The behavior of matter in the universe can be described on a statistical basis.

4. Units of matter interact. The bases of all ordinary interaction are electromagnetic, gravitational and nuclear forces.

5. All interacting units of matter tend toward equilibrium in which energy content (enthalpy) is a minimum and the energy distribution (entropy) is most random. In the process of attaining equilibrium, energy transformation occurs. Nevertheless, the sum of energy and matter in the universe remains constant.

6. One of the forms of energy is the motion of units of matter. Such motion is responsible for heat and temperature and for the states of matter: solid, liquid and gaseous.

7. All matter exists in time and space and, since interaction occurs among its units, matter is subject in some degree to changes in time. Such changes may occur at various rates and in various patterns.

NEW ELEMENTARY SCIENCE PROGRAMS

The following are brief descriptions of some of the new programs being developed for elementary school science. Some of these are in published form and others are in the experimental stage. Addresses are given so that the principal or supervisor can write for specific information regarding these programs.

AAAS - (American Association for the Advancement of Science) "Science - A Process Approach"

Stresses the spirit of discovery as a characteristic of science. Processes used by scientists - observation, classification, prediction, inference, measurement, etc., are also used by the student. Objectives are behavioral and are tested at the end of each activity by the teacher, individually or by the group. Lessons are planned for each grade with emphasis on basic skills.

Write to: AAAS Commission on Science Education
1515 Massachusetts Avenue, N. W.
Washington, D. C.

SCIS - Science Curriculum Improvement Study

A science program based on a hierarchial arrangement of levels of abstractions:

1st level - conceptions of matter, living matter, conservation of matter and variation.

2nd level - conceptions of interaction and relativity.

3rd level - conceptions of energy, equilibrium, steady state, behavior, reproduction and speciation.

Units for each level of abstraction will be available upon completion along with materials and equipment kits for the entire program.

Write to: Science Curriculum Improvement Study
Department of Physics
University of California
Berkeley, California

COPES - Conceptually Oriented Program in Elementary Science K-6

An elementary science sequence related to concepts of energy conservation.

Write to: Dr. Morris H. Shamos
Washington Square College, New York University
New York, New York

ESS - Elementary Science Study

This study is developing a series of experimental topics from kindergarten through 8th grade that can be used at the discretion of the teacher during the year. A variety of self-contained kits are available which encourage student investigations in physical and life science areas. Some are simple and short-term, others are more elaborate and require a substantial amount of material.

Write to: Randolph R. Brown
Elementary Science Study
Educational Development Center
55 Chapel Street
Newton, Massachusetts 02160

ESSP (C) - Elementary School Science Project - California

Instructional units built on fundamental concepts. Units foster inductive thinking - force, animal coloration, plants and their development.

Write to: Elementary School Science Project
Department of Botany
University of California
Berkeley, California

ESSP (I) - Elementary School Science Project - Illinois

This project was undertaken to assess student reaction to a study of specific astronomy topics. Teaching units have been developed.

Write to: Elementary School Science Project
University of Illinois
805 W. Pennsylvania Avenue
Urbana, Illinois

ESSP (H) - Elementary School Science Project

This project is designed to create an elementary science sequence of experiences for disadvantaged children.

Write to: Elementary School Science Project
Department of Education and Physics
Box 574
Howard University
Washington, D. C.

EVALUATING THE ELEMENTARY SCIENCE PROGRAM
(A Role of the Principal)

In order to evaluate a program, the objectives of that program must be known.

Observation is the best means by which a principal can evaluate a program in his school.

Things to look for while observing:

- Are lessons being presented to stress the objectives?
  (A teacher's tests reveal the objectives which he considers important.)
- Are the students actively involved in meaningful experiences? Are there ample space and facilities to permit laboratory type instruction?
- What type of questions do the teachers ask?
  Do they encourage exploration? Are they thought provoking?
- Does the teacher, knowingly or unknowingly, demand certain types of answers from students? Demanding too exact answers can squelch excitement.
- What type of questions do students ask? Do they indicate depth of thought?
- What type of answers do students give? Do they express themselves well?
  Do discussions on a problem occur among the students?
- Is there opportunity or provision for students to raise questions and problems of importance or interest to them?
- Do students enter the room faster than they leave?
- Is communication good between the teacher and the students and among the students?
- Does the teacher "follow-up" new ideas or new approaches to a problem expressed by students?
- Is the teacher eager to explore the world of science in full partnership with the students?
- Are students commended for good work and/or responses?
- Does the science vocabulary of the students improve as the year goes by? Are they able to express their ideas more clearly?
- Do the atmosphere and room arrangement lend themselves to purposeful learning?
- Are there well-cared-for living things in the room?

. To what extent are natural resources utilized?

. Is science being correlated with other subject matter areas?

Library circulation records might be used to spot areas that are being emphasized.

Follow-up studies of students from elementary to junior high to senior high and beyond can serve to help evaluate the elementary science program.

Teachers who are active in professional organizations are usually more up-to-date on new developments.

Questions to be answered by the principal

. Do the time schedule, the class assignments and room assignments allow for the most efficient use of the instructional personnel?

. Are the backgrounds and experiences of all the teachers being fully employed?

. Are equipment and materials available in sufficient quantity and variety to provide experiences for all students in the biological and physical sciences at varying levels? Are they distributed equitably among the teachers?

. To what extent have the teachers participated in recent in-service programs?

. Are sufficient funds provided for the program?

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